CLAIMS

1. (canceled)

2. (canceled)

3. (currently amended) The method of any of any of Claims 31-34 ~~Claim 28~~, wherein the user may interactively debug a behavioral model by single stepping through the simulation.

4. (currently amended) The method of any of Claims 31-34 ~~Claim 28~~, wherein the user may interactively debug a behavioral model when one of a statement breakpoint, an object value change breakpoint, or a write access breakpoint is triggered in the simulation.

5. (canceled)

6. (canceled)

7. (previously presented) A method for debugging of signal behavioral models, comprising the steps of:

(1) setting a trial time to start a transient analysis algorithm;
(2) initializing Newton-Raphson iteration;
(3) linearizing about the previous iteration;
(4) choosing a model instance;
(5) choosing a sequential statement;
(6) executing said sequential statement;
(7) testing whether said sequential statement is the last statement;
(8) switching to a next statement and going to step (6) if the result of step (7) is false;

(9) adding contributions to matrix A and vector b of a matrix equation Ax=b if the result of step (7) is true;

(10) testing whether said model is the last model;

(11) switching to a next model and going to step (5) if the result of step (10) is false;

(12) solving said matrix equation Ax=b if the result of step (10) is true;

(13) testing whether the solution of said matrix equation Ax=b converges;

(14) moving to a next iteration and going to step (3) if the result of step (13) is false;

(15) testing whether the trial timepoint is acceptable if the result of step (13) is true;

(16) rejecting said trial timepoint, choosing an alternate timepoint, and moving to step (2) if the result of step (15) is false;

(17) testing whether debugging is needed if the trial timepoint is accepted at step (15);

(18) testing whether said alternate timepoint is the last time point if the result of step (17) is false;

(19) moving to a next timepoint and moving to step (2) if the result of step (18) is false; and

(20) finishing said algorithm if the result of step (18) is true; and

wherein the last Newton-Raphson iteration of said accepted timepoint is replayed if the result of step (17) is true; and

wherein said replay of the last Newton-Raphson iteration comprises the steps of:

(21) choosing model instance;

(22) choosing sequential statement;

(23) testing whether the user is debugging by single stepping through the simulation or a statement breakpoint is encountered at said sequential statement;

(24) going interactive and then moving to step (25) if the result of step (23) is true;

(25) executing said sequential statement if the result of step (23) is false or preceded by step (24);

(26) testing whether a value change breakpoint or a write access breakpoint has occurred on an object of interest to the user;

(27) going interactive and then moving to step (28) if the result of step (26) is true;

(28) testing whether said sequential statement is the last statement if the result of step (26) is false or preceded by step (27);

(29) moving to a next statement and moving to step (23) if the result of step (28) is false;

(30) testing whether said model is the last model;

(31) moving to a next model and moving to step (22) if the result of step (30) is false;

(32) moving to step (18) if the result of step (30) is true.

8. (original) The method of Claim 7 is implemented on a simulator for solving systems of non-linear equations which can be represented by behavioral models.

9. (original) The method of Claim 7 is implemented on an analog circuit simulator.

10. (original) The method of Claim 7 is implemented on a mixed-signal simulator which comprises at least one digital simulation engine and at least one analog simulation engine.

11. (original) The method of Claim 7 is implemented on a partitioned and multi-rated analog circuit simulator.

12. (original) The method of Claim 7 is implemented on a mixed-signal simulator

which comprises at least one digital simulation engine and at least one partitioned and multi-rated analog simulation engine.

13. (canceled)

14. (canceled)

15. (canceled)

16. (canceled)

17. (canceled)

18. (canceled)

19. (canceled)

20. (previously presented) A computer usable medium containing instructions in computer readable form for carrying out a process for debugging of signal behavioral models, wherein said process comprises the steps of:

(1) setting a trial time to start a transient analysis algorithm;

(2) initializing Newton-Raphson iteration;

(3) linearizing about the previous iteration;

(4) choosing a model instance;

(5) choosing a sequential statement;

(6) executing said sequential statement;

(7) testing whether said sequential statement is the last statement;

(8) switching to a next statement and going to step (6) if the result of step (7) is false;

(9) adding contributions to matrix A and vector b of a matrix equation Ax=b if the result of step (7) is true;

(10) testing whether said model is the last model;

(11) switching to a next model and going to step (5) if the result of step (10) is false;

(12) solving said matrix equation Ax=b if the result of step (10) is true;

(13) testing whether the solution of said matrix equation Ax=b converges;

(14) moving to a next iteration and going to step (3) if the result of step (13) is false;

(15) testing whether the trial timepoint is acceptable if the result of step (13) is true;

(16) rejecting said trial timepoint, choosing an alternate timepoint, and moving to step (2) if the result of step (15) is false;

(17) testing whether debugging is needed if the trial timepoint is accepted at step (15);

(18) testing whether said alternate timepoint is the last time point if the result of step (17) is false;

(19) moving to a next timepoint and moving to step (2) if the result of step (18) is false; and

(20) finishing said algorithm if the result of step (18) is true; and

wherein the last Newton-Raphson iteration of said accepted timepoint is replayed if the result of step (17) is true; and

wherein said replay of the last Newton-Raphson iteration comprises the steps of:

(21) choosing model instance;

(22) choosing sequential statement;

(23) testing whether the user is debugging by single stepping through the simulation or a statement breakpoint is encountered at said sequential statement;

(24) going interactive and then moving to step (25) if the result of step (23) is true;

(25) executing said sequential statement if the result of step (23) is false or preceded by step (24);

(26) testing whether a value change breakpoint or a write access breakpoint has occurred on an object of interest to the user;
(27) going interactive and then moving to step (28) if the result of step (26) is true;
(28) testing whether said sequential statement is the last statement if the result of step (26) is false or preceded by step (27);
(29) moving to a next statement and moving to step (23) if the result of step (28) is false;

(30) testing whether said model is the last model;
(31) moving to a next model and moving to step (22) if the result of step (30) is false;
(32) moving to step (18) if the result of step (30) is true.

21. (original) The computer usable medium of Claim 20, wherein said process is implemented on a simulator for solving systems of non-linear equations which can be represented by behavioral models.

22. (original) The computer usable medium of Claim 20, wherein said process is implemented on an analog circuit simulator.

23. (original) The computer usable medium of Claim 20, wherein said process is implemented on a mixed-signal simulator which comprises at least one digital simulation engine and at least one analog simulation engine.

24. (original) The computer usable medium of Claim 20, wherein said process is implemented on a partitioned and multi-rated analog circuit simulator.

25. (original) The computer usable medium of Claim 20, wherein said process is implemented on a mixed-signal simulator which comprises at least one digital simulation engine and at least one partitioned and multi-rated analog simulation

engine.

26. (original) The computer usable medium of Claim 20, wherein said instructions in a computer readable form may be downloaded from a website over the Internet.

27. (canceled)

28. (canceled)

29. (canceled)

30. (canceled)

31. (new) A method for interactive debugging of mixed signal behavioral models, comprising the steps of:

advancing simulation time by iterating over a sequence of trial timepoints, from a desired initial time to a desired end time, where for each trial timepoint:

a system of non-linear ordinary differential equations representing circuit model behavior at that point in time is constructed, linearized, and solved wherein timepoint processing comprises insertion of additional steps to allow interactive debugging of accepted timepoints only before moving onto a next trial timepoint and continuing simulation algorithm execution, and wherein linearizing and solving of non-linear ordinary differential equations comprise an iterative fixed point iteration method, comprising the steps of:

iterating over a number of trial solutions, beginning with an initial guess at a trial solution, and making improved guesses at a next trial solution until convergence via construction and solution of a system of linearized non-differential equations per a fixed point iteration scheme, comprising any of a fixed point iteration, Newton Raphson iteration, or Secant Method, in which time derivative terms are numerically approximated by an integration formula, comprising any of backward Euler, forward Euler, or trapezodial first order methods, and higher order methods and wherein said system of linear equations is constructed and solved, and a determination made if a solution and timepoint are numerically acceptable and exhibit sufficient stability properties via integration error bounding, where construction and solution of a system of linearized equations comprise the step of:

iterating over each device model to be simulated, where for each device model that model's contributions to an overall system of linear equations is evaluated and contributed to said system of linearized equations and, at the end of said model iteration, said overall linear system is solved via a matrix inversion technique.

32. (new) A method of allowing in-simulation interactive user debugging of behavioral simulation, simulation models comprising the step of:

a replaying of a final linear iteration, for accepted timepoints only, of an iterative solution process in which a system of non-linear ordinary differential equations is linearized and solved at any trial timepoint in a circuit simulator , wherein said iteration replay step further comprises the step of inserting of additional simulation steps iterating over each device model to be simulated, where for each such model its behavioral statements are iterated upon, wherein before evaluation of each such

behavioral statement said simulation allows user interaction when in single stepping debug mode or when a statement breakpoint is encountered, and after execution of each model behavioral statement said simulation again allows user interaction if a value change breakpoint or write access breakpoint is triggered by a statement; said user interaction allowing said user to issue further debugging commands or queries, and set further debug breakpoints.

33. (new) A method for interactive debugging of mixed signal behavioral models comprising the steps of:

advancing simulation time by iterating over a sequence of trial timepoints, from a desired initial time to a desired end time, where for each trial timepoint:

a system of non-linear ordinary differential equations representing circuit model behavior at that point in time is constructed and solved wherein timepoint processing further comprises insertion of additional steps which allow user interactive debugging during a final iteration replay of only accepted timepoints, before moving onto a next trial timepoint and continuing simulation algorithm execution, and wherein said non-linear ordinary diffential equation solution comprises an iterative fixed point iteration, comprising the steps of:

iterating over a number of trial solutions, beginning with an initial guess at a trial solution, and making improved guesses at a next trial solution until convergence via construction and solution of a system of linear non-differential equations per a fixed point iteration scheme comprising any of fixed point iteration, Newton Raphson iteration, or Secant method, in which time derivative terms are numerically approximated by an

appropriate integration formula comprising any of backward Euler, forward Euler, or trapezodial first order methods, and higher order methods and wherein said system of linear equations is constructed and solved, and a determination made if said solution and timepoint are numerically acceptable and exhibit sufficient stability properties via integration error bounding, and where construction and solution of a system of linear equations comprise the step of:

iterating over each device model to be simulated, where for each device model that model's contributions to an overall system of linear equations is evaluated and contributed to said system of linear equations and, at the end of said model iteration, said overall linear system is solved via a matrix inversion technique; and

further comprising the step of iteration replay, comprising the steps of again iterating over each device model to be simulated, where for each such model its behavioral statements are iterated upon, wherein before evaluation of each such behavioral statement said simulation allows user interaction when in single stepping debug mode or when a statement breakpoint is encountered, and after execution of each model behavioral statement said simulation again allows user interaction if a value change breakpoint or write access breakpoint is triggered by a statement; said user interaction allowing said user to issue further debugging commands or queries set further debug breakpoints.

34. (new) A method for debugging of mixed signal behavioral models, using an extended Newton-Raphson-based mixed signal simulator algorithm, is comprising the steps of:

advancing simulation time by iterating over a sequence of trial timepoints, from a desired initial time to a desired end time, where for each trial timepoint:

system of non-linear ordinary differential equations representing circuit model behavior at that point in time is constructed and solved by of testing at acceptable timepoints only if interactive debugging is requested and, if so, allowing interactive debugging during these acceptable timepoints via iteration replay before moving onto a next trial timepoint, and continuing simulation algorithm execution, and wherein non-linear ordinary differential equation solution comprises an iterative method comprising the steps of:

iterating over a number of trial solutions, beginning with an initial guess at a trial solution, and making improved guesses at a next trial solution until convergence via construction and solution of a system of linear non-differential equations per a Newton Raphson iteration scheme, in which time derivative terms are numerically approximated by an appropriate integration formula, comprising any of backward Euler, forward Euler, or trapezodial first order methods, and higher order methods , and wherein said system of linear equations is constructed and solved, and a determination made if a solution and timepoint are numerically acceptable and exhibit sufficient stability properties via integration error bounding, wherein construction and solution of a system of linear equations comprises the steps of:

iterating over each device model to be simulated, where for each device model that model's contributions to an overall system of linear equations is evaluated and contributed to said system of linear equations, and at the end of said model iteration an overall linear system is solved via a matrix inversion technique;

further comprising the step of replaying a last linear equation iteration of a last accepted timestep if interactive debugging is requested, said iteration replay comprising the steps of again iterating over each device model to be simulated, where for each such model its behavioral statements are iterated over, wherein before evaluation of each behavioral statement said simulation allows user interaction when in single stepping debug mode or when a statement breakpoint is encountered, and after execution of each model behavioral statement said simulation again allows user interaction if a value change breakpoint or write access breakpoint is triggered by statement; the said user interaction allowing said user to issue further debugging commands or queries, and set further debug breakpoints.

35. (new) The method of any of Claims 31-34 comprising instructions in computer readable form on a computer usable medium.

36. (new) The method of Claim 35 wherein the instructions in computer readable form may be downloaded from websites over the Internet.

37. (new) The method of any of Claims 31-35 implemented on a simulator for solving systems of non-linear equations which can be represented by behavioral models.

38. (new) The method of any of Claims 31-35 implemented on an analog circuit simulator.

39. (new) The method of any of Claims 31-35 implemented on a mixed-signal simulator which comprises at least one digital simulation engine and at least one analog simulation engine.

40. (new) The method of any of Claims 31-35 implemented on a partitioned and multi-rated analog circuit simulator.

41. (new) The method of any of Claims 31-35 implemented on a mixed-signal simulator which comprises at least one digital simulation engine and at least one partitioned and multi-rated analog simulation engine.